Effect of two sous vide cooking methods on physicochemical characteristics and on fatty acid composition of *Longissimus thoracis et lumborum* muscle from pigs fed with or without extruded linseed

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Introduction

Nowadays, the attention of the consumer is both on food quality, its nutritional value and new cooking methods. Meat is a good source of protein, fat-soluble vitamins and fatty acids. By adopting proper feeding technique is possible to modify the fatty acid (FA) composition in pork, in order to obtain meat with a better value of n-6/n-3 FA ratio, with good effect on human health. During the cooking process, several modifications occur on the food, meat proteins become more digestible and lipid oxidation increases the production of undesirables substances (Jeong et al., 2018). High temperature for short time could favour the formation of lipid oxidation compound. The sous vide cooking method could represent a good alternative to classical cooking methods and a way to preserve the overall meat quality. The aim of this study was to evaluate the effects of two different sous vide cooking conditions on physicochemical characteristics and on fatty acid composition of *Longissimus thoracis et lumborum* (LTL) muscle, from pigs fed with or without extruded linseed.

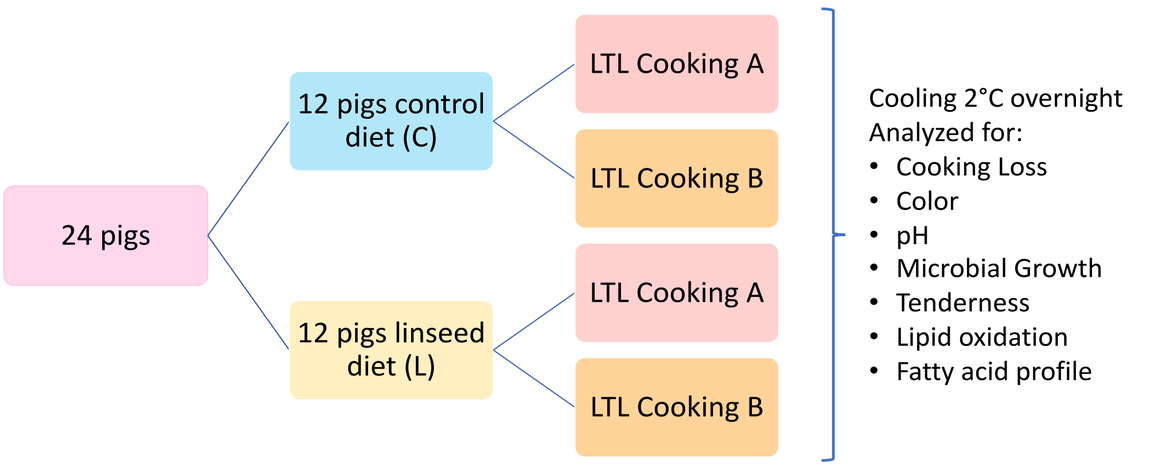

Figure 1. Experimental flow diagram

Methodology

Twenty four middle weight finishing pigs, evenly divided into two groups of 12 subjects each, were used. One group received a barley-soya bean meal diet (C) and the second was given the same feed where 5% of extruded linseed partly replaced the barley, to obtain a diet enriched with n-3 FA (L). Cooking loss, colour parameters (L*, a*, b*) of external and internal parts, pH value, microbial growth, tenderness, fatty acid profile and lipid oxidation were determined on the LTL muscle. The samples were cooked in a water bath according to two different methods: high temperature (80°C) and short time (left until the core temperature reached 70°C) (A), the second condition was low temperature (60°C) for long time (15h) (B). Fig. 1 shows the experimental flow diagram.
Microbial growth was analysed for the enumeration of mesophilic aerobic bacteria and for the Enterobacteriaceae. The tenderness (WBSF) was measured with the dynamometer Zwick/Roell Z1.0. Oxidative stability was measured by the dosage of the 2-thiobarbituric acid reactive substances (TBARS) and FA composition was determined by capillary gas chromatography (Ficarra et al., 2010) The statistical analysis was performed by means of ANOVA, using the GLM procedure of SAS. Dietary treatments (C vs L) and cooking methods (A vs B) were used as independent variables.

Results

The cooking conditions did not affect FA composition nor lipid oxidation of LTL muscle. Tenderness and colour parameters of the meat were affected by cooking methods. LTL samples cooked with A condition showed higher values of shear force (5.027 *vs* 3.299 N/kg; P< 0.01)(Fig. 2). The redness parameter (a*) (internal part) was affected by the cooking condition, (A vs B, 3.97 *vs* 4.74; P<0,05) as well as the yellowness parameter (b*) (external part) (A vs B, 15.84 vs 17.79, P<0.05) (Fig. 3). Both of cooking method showed low microbial growth but with no significant differences among them (A vs B, 0.50 $\log_{10}$ vs 0.64 $\log_{10}$, P>0.05; data not reported). Dietary treatments (C *vs* L) affected some FA but not lipid oxidation. In particular, extruded linseed feeding brought about an increase (on total FA) of the percentage of total n-3 FA (2.67 vs 0.98 %; P<0.01) and it allowed to have a more favourable n-6/n-3 ratio (3.68 vs 10.42; P< 0.01) (Fig. 4). Table 1 shows the fatty acid composition (% of total FA) of *Longissimus thoracis et lumborum* (LTL) muscle, most of the FA belonging to n-3 family were significant higher in L group. Overall, L samples had a higher content of polyunsaturated FA (12.02 *vs* 9.68 %; P<0.05) and a lower content of monounsaturated (44.41 *vs* 46.65 %; P<0.05). Saturated FA content was non affected by dietary treatments (Fig.5).

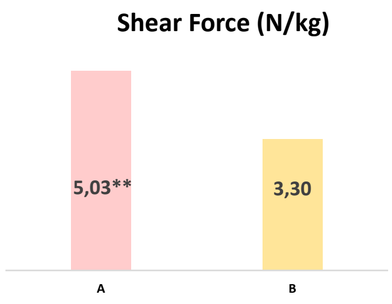

Figure 2. Shear force value (N/kg)
** P< 0.01

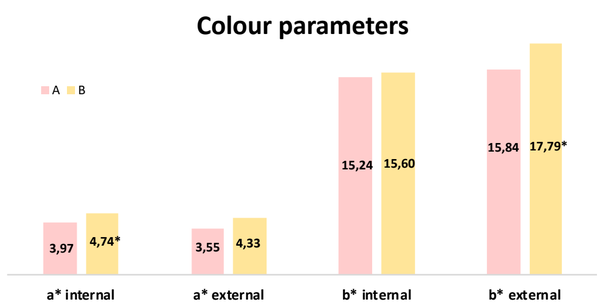

Figure 3. a and b* colour parameters of Longissimus thoracis et lumborum (LTL) muscle after cooking*
* P< 0.05

Table 1. Fatty acid (FA) composition (% of total FA) of cooked *Longissimus thoracis et lumborum* (LTL) muscle

FA (%)	Dietary treatments		RMSE
	C	L	
C 10	0,126	0,127	0,016
C 12	0,096	0,112	0,043
C 14	1,421	1,464	0,107
C 16	25,655	25,372	1,167
C 16:1	2,708*	2,464	0,280
C 17	0,215	0,219	0,051
C 17:1	0,220	0,205	0,044
C 18	16,148	16,079	1,603
C 18:1 ω9	40,502*	38,066	2,156
C 18:1 ω7	2,233	2,100	0,737
C 18:2 ω6	7,373*	8,055	1,136
C 18:3 ω6	0,141	0,124	0,035
C 18:3 ω3	0,693*	2,121	0,535
C 20	0,200	0,203	0,050
C 20:1	0,795	1,544	2,666
C 20:2 ω6	0,335	0,353	0,062
C 20:3 ω6	0,099	0,103	0,040
C 20:4 ω6	0,602	0,519	0,176
C 20:3 ω3	0,177*	0,326	0,070
C 20:5 ω3	0,009*	0,026	0,007
C 22:1	0,006*	0,027	0,018
C 22:2 ω6	0,044*	0,110	0,031
C 22:4 ω6	0,101	0,084	0,058
C 22:5 ω3	0,085*	0,182	0,098
C 22:6 ω3	0,016	0,014	0,015

* P< 0.05

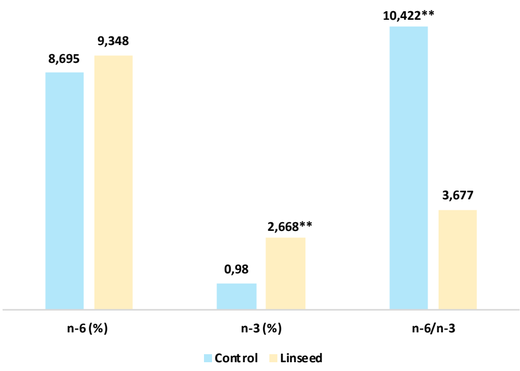

Figure 4. n-6, n-3 content (% total FA) and n-6/n-3 ratio of cooked Longissimus thoracis et lumborum (LTL) muscle.
** P< 0.01*

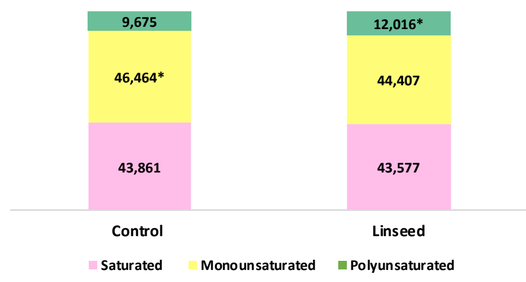

Figure 5. Fatty acid composition (% total FA) of cooked Longissimus thoracis et lumborum (LTL) muscle.
* P< 0.05

Conclusion

The dietary treatment with extruded linseed is a good way to improve the meat quality, especially to modify the fatty acids composition, in order to answer to the consumer's request. The application of the sous vide technique seems to be a good compromise to obtain safe meat and final products with better nutritional value. The combination of long time and low temperature cooking condition and feeding strategy for animal could represent a good way to ameliorate pig meat quality characteristics.

Aknowledgments

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